Claims

1. A low loss micro-ring resonator device (10; 100; 10') comprising
   - a closed-loop resonator waveguide (2) having a first refractive index (n_r), said resonator waveguide (2) defining an inner (16) and an outer region (17) by an outer curved edge (15) of said waveguide (2), said resonator waveguide being arranged on a substrate (6; 6') having a second refractive index (n_b), the refractive index difference (Δn_1) between said first refractive index (n_r) and said second refractive index (n_b) being greater than 0.3;
   - an upper cladding (20) covering said inner region (16) of said resonator waveguide (2) having a third refractive index (n_{uc}); and
   - a lateral cladding (21) in contact with said outer curved edge (15) and extending in said outer region (17), said lateral cladding (21) having a fourth refractive index (n_{lc}), said fourth refractive index (n_{lc}) being lower than said third refractive index (n_{uc}).
2. A resonator device (10; 100;10') according to any one of the preceding claims, in which said upper cladding (20) comprises a tunable material.
3. A resonator device (10; 100; 10') according to claim 1 or 2, wherein at least one of the dimensions of the cross-section of said closed-loop resonator waveguide (2) is of the order of $\frac{\lambda}{n_{eff}}$, being n_{eff} the effective index of the resonator waveguide (2) and λ the wavelength of a propagating mode in the resonator waveguide (2).
4. A resonator device (10; 100; 10') according to any one of the preceding claims, comprising a first waveguide (3a) being in substantially close proximity to said resonator waveguide (2) in a predetermined region to provide coupling there between.
5. A resonator device (10; 100; 10') according to any one of the preceding claims, wherein said resonator waveguide (2) is a single mode waveguide.
6. A resonator device (10; 100; 10') according to any one of the preceding claims, wherein said resonator waveguide (2) comprises silicon compound materials.
7. A resonator device (10; 100; 10') according to any one of the preceding claims, wherein said substrate (6;6') comprises silicon compound materials.
8. A resonator device (10; 100;10') according to any one of claims 4 to 7, comprising a second waveguide (3b), said first waveguide (3a) being adapted for carrying an input signal (11) having at least a channel of a given wavelength (λ_1), and said

resonator waveguide (2) being operable so that said given wavelength (λ_1) is transferred to said second waveguide (3b).

9. A resonator device (10; 100;10') according to claim 8, wherein said input signal (11) includes a given number of optical channels having wavelengths (λ_1,....., λ_n) comprised between about 1530 and about 1565 nm.

10. A resonator device (10; 100;10') according to any one of the preceding claims, wherein the radius of the closed-loop resonator waveguide (2) is comprised between 5 and 10 μm.

11. A resonator device (10; 100;10') according to claim 10, wherein the radius of the closed-loop resonator waveguide (2) is not larger than 8 μm.

12. A resonator device (10; 100;10') according to any one of the preceding claims, wherein the closed-loop resonator waveguide (2) is a ring.

13. A resonator device (10; 100;10') according to any one of claims 8 to 12, wherein said resonator waveguide (2) and said waveguides (3a, 3b) are arranged in a lateral coupling configuration.

14. A resonator device (10; 100;10') according to any one of claims 8 to 12, wherein said resonator waveguide (2) and said waveguides (3a, 3b) are arranged in a vertical coupling configuration.

15. A resonator device (10; 100;10') according to any one of claims 2 to 14, wherein the third refractive index (n_{uc}) of said tunable material can be varied upon variation of an external parameter.

16. A resonator device (10; 100;10') according to claim any one of claims 2 to 15, wherein the tunable material is variable with temperature (T) and said tunable material has a ratio $|\frac{\Delta n}{n}|$ between the variation Δn of the third refractive index (n_{uc}) and the refractive index (n_{uc}) of said tunable material not smaller than 10^{-2} for a temperature variation not larger than 100°C.

17. A resonator device (10; 100;10') according to any of claims 2 to 16, wherein the tunable material is variable with an electric field (E) and said tunable material has a ratio $|\frac{\Delta n}{n}|$ between the variation Δn of the refractive index (n_{uc}) and the refractive index (n_{uc}) of said tunable material not smaller than 10^{-2} for an electric field variation not larger than 5 V/μm.

18. A resonator device (10; 100;10') according to any of claims 2 to 16, wherein the refractive index (n_{uc}) of said tunable material is variable with temperature (T) and

said tunable material has a thermo-optic coefficient $\left|\frac{dn}{dT}\right|$ greater than or equal to 10^{-4}/°C.

19. A resonator device (10; 100;10') according to any of claims 2 to 16 or 18, wherein said tunable material variable with temperature (T) is a polymer.
20. A resonator device (10; 100;10') according to any of claims 2 to 15 or 17, wherein said tunable material is a liquid crystal.
21. A resonator device (10; 100;10') according to any one of the preceding claims, wherein said lateral cladding (21) comprises a tunable material.
22. An add/drop optical device comprising one of more of the resonator device (10;100;10') according to one or more of the claims 1-21.
23. A method to reduce the propagation losses of a resonator device (10; 100;10'), comprising the steps of:
    - realizing a closed loop resonator waveguide (2) having a first refractive index (n_r) on a substrate (6;6') having a second refractive index (n_b), the refractive index difference (Δn_1) between said first refractive index (n_r) and said second refractive index (n_b) being greater than 0.3, said resonator waveguide (2) defining an inner (16) and an outer region (17) by an outer curved edge (15) of said waveguide (2);
    - adding an upper layer in said inner region (16) having a third refractive index (n_{uc}) greater than a fourth refractive index (n_{lc}) of a lateral cladding (21) in contact with said outer curved edge (15) of said resonator waveguide (2) and extending in said outer region (17).
24. A method according to claim 23, comprising the step of realizing said lateral cladding (21) depositing a layer of material on said outer region (17).
25. A method according to claim 23 or 24, wherein said upper cladding (20) is realized in a tunable material.